KAUSS

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Description

Valve arrangement for the pilot control of a first and a second hydraulically actuatable directional valve

FIELD AND BACKGROUND OF THE INVENTION

The invention is based on a valve arrangement which is intended for the pilot control of two hydraulically actuatable directional valves and which comprises the features of the preamble of claim 1.

A valve arrangement for the pilot control of a first and a second hydraulically actuatable directional valve is known, for example, from DE 39 19 640 A1 or DE 38 12 753 A1. The arrangements shown in these publications comprise one or more pilot control devices, which operate on the basis of directly controlled pressure-reducing valves. Each pressure-reducing valve possesses a control output that is connected or can be connected to precisely one control chamber of one of a plurality of directional valves. Accordingly, the number of pressure-reducing valves and the number of control lines leading from the pilot control devices to the directional valves coincides with the number of control chambers at the various directional valves. Customarily, a directional valve can be proportionally adjusted out of a neutral position by subjecting a first control chamber to the action of a control pressure in a first direction and by subjecting a second control chamber to the action of a control pressure in a

second direction. Each directional valve thus customarily has two control chambers, so that for two directional valves a total of four of the pilot control pressure valves, usually constructed as pressure-reducing valves, are necessary.

The pilot control pressure valves are relatively costly devices. Hence, efforts are made to reduce the number of pilot control pressure valves necessary to control two directional valves. This is possible in accordance with DE 196 30 798 A1, which presents a valve arrangement in accordance with the preamble of claim 1, at least if two directional valves are assigned to two hydraulic consumers, which are normally not actuated simultaneously. According to DE 196 30 798 A1, only two pilot control valves, constructed as pressure-reducing valves, are present in order to actuate the two directional valves. The control output of a pressure-reducing valve leads to a first 4/2-way directional switching valve, which in a first switching position connects the first control chamber of the first directional valve and in a second switching position connects the first control chamber of the second directional valve to the control output of the first pressure-reducing valve and discharges the respective other first control chamber to the tank. From the control output of the second pressure-reducing valve, a line leads to a second 4/2-way directional switching valve, which in a first switching position connects the second control chamber of the first directional valve to the control output and in a

second switching position connects the second control chamber of the second directional valve to the control output of the pressure-reducing valve and discharges the respective other second control chamber to the tank. By comparison with valve arrangements in which a total of four pilot control pressure-reducing valves are used to control two proportionally adjustable directional valves, then, only two pilot control pressure-reducing valves are now present and two further pilot control pressure-reducing valves are replaced by much more cost-effective switching valves.

a SUMMARY OF THE INVENTION

It is an object of the invention to design a valve arrangement, which serves for the pilot control of two proportionally actuatable directional valves and comprises the features of the preamble of claim 1, in such a way that the effort needed for the pilot control of the directional valves can be further reduced and the costs associated therewith can also be further reduced.

This object is achieved with a valve arrangement having the features of the preamble of claim 1, in that a second switching valve arrangement is present, via which, in a first switching position, the second control chambers of the two directional valves are jointly connected to the control output of the pilot control pressure valve and via which, in a second switching position, the second control chambers of the two directional valves are jointly relieved of pressure.

The basic concept of the invention lies in the fact that the first switching valve arrangement is used not only to adjust the two directional valves in the first direction but also the first switching valve arrangement is also jointly used for the adjustment of the directional valves in the second direction. Specifically, if a directional valve is to be adjusted in the second direction, the second switching valve arrangement is brought into the first switching position in which both second control chambers of the directional valves are subjected to the action of the pressure existing at the control output of the pilot control pressure valve. Depending on which directional valve is to be actuated, the first switching valve arrangement is brought into the first switching position or into the second switching position, in which the first control chamber of one directional valve is likewise subjected to the action of the pressure existing in the control output of the pilot control pressure valve, while the first control chamber of the other directional valve is relieved of pressure. Accordingly, only the latter directional valve is adjusted in the second direction. At the first directional valve, the forces exerted in opposite directions by the control pressure cancel out. Thus, for controlling two proportionally actuatable directional valves, only one pilot control pressure valve is now used. The other valves used are switching valves, which are relatively cost-effective.

Advantageous embodiments of the valve arrangement according to the invention can be found in the dependent claims.

According to claim 2, the first switching valve arrangement is formed by a first and a second 3/2-way directional switching valve. In this case, it is conceivable to bring both switching valves of the first switching valve arrangement into a switching position in which both the first control chamber of the first directional valve and the first control chamber of the second directional valve are subjected to the action of the pressure prevailing at the control output of the pilot control pressure valve. It is therefore possible to adjust, in each case, only one of the two directional valves, or both directional valves jointly, in the first direction. In the latter case, of course, the two directional valves are then coupled to one another in the adjustment travel so that the corresponding hydraulic consumers are not actuated independently of one another.

According to claim 3, the first switching valve arrangement is preferably formed by a single directional switching valve via which, in a first switching position, the first control chamber of the first directional valve is connected to the control output of the pilot control pressure valve and the first control chamber of the second directional valve is connected to the tank, and in a second switching position the first control chamber of the second directional valve is

connected to the control output of the pilot control pressure valve and the first control chamber of the first directional valve is connected to the tank. If no adjustment of the directional valve is desired, tank pressure prevails at the control output of the pilot control pressure valve. Thus, irrespective of the switching position in which the switching valve arrangements are, neither of the two directional valves is controlled. Only when a control pressure is built up by an adjustment of the pilot control pressure valve is one of the directional valves adjusted in the first or second direction, depending upon the switching position of the switching valve arrangements. With regard to the function of the second switching valve arrangement, this is preferably formed by a 3/2-way directional switching valve.

The pilot control pressure valve and the directional switching valves are preferably actuated by solenoids.

As already indicated, the directional valves are customarily controlled by means of a manually actuatable pilot control device which possesses a handle which can be pivoted to guide the directional valves out of a neutral position in various directions. In this case, the pilot control pressure valve is either directly mechanically adjusted or an electrical signal is generated by means of which an electrical setting member of the pilot control pressure valve is controlled. Advantageously, in accordance with claim 7, the first

switching valve arrangement and the second switching valve arrangement are non-arbitrarily switched as a function of the pivot direction of the handle, so that the operator need not perform any additional actuation movements apart from the movement of the handle. It is conceivable here to dispose electrical switches in the pilot control device which are selectively actuated as a function of the pivot direction of the handle. In a purely electrical pilot control device, however, according to claim 9, the value of the respective control signal can be used to switch the switching valve arrangements.

BRIEF DESCRIPTION OF THE DRAWINGS

A plurality of examples of embodiment of a valve arrangement according to the invention are shown in the drawings. The invention will now be explained in detail with reference to the figures of those drawings, in which:

figure 1 shows a first example of embodiment in which the pilot control pressure valve is a pressure-reducing valve that can be adjusted by a solenoid and the first switching valve arrangement is formed by two 3/2-way directional switching valves,

figure 2 shows a second example of embodiment, which again comprises a solenoid-adjustable pressure-reducing valve as a pilot control pressure valve and whose first switching valve arrangement is formed by a 4/2-way directional switching valve,

figure 3 shows, diagrammatically, an electrical pilot control device which comprises two potentiometers and six electrical switches for adjusting the pressure-reducing valve and for switching over the directional switching valves of the example of embodiment shown in figure 1,

figure 4 shows an electrical pilot control device with only two potentiometers, which can likewise be used for the example of embodiment shown in figure 1, and

figure 5 shows an electrical pilot control device which is constructed correspondingly to that shown in figure 3 and can be used for the example of embodiment shown in figure 2.

a DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figures 1 and 2 show a first directional valve 10 and a second directional valve 11, each of which comprises four working connections P, T, A and B. The working connection P is the inlet connection, to which pressure medium flows from a hydraulic pump 12, and the working connection T is the output connection, from which pressure medium flows back to a tank 13. The working connections A and B are each provided for connection to a hydraulic consumer (not shown in detail), for example a differential cylinder. The directional valves 10 and 11 adopt a central neutral position under the action of two compression springs 14, in which the four working connections are shut off from one another. They are formed as "proportional directional valves" and are continuously

adjustable in opposite directions from the neutral position into a working position in which one working connection is connected to the inlet connection P and the other working connection to the output connection T. The two directional valves 10 and 11 are hydraulically actuatable. They therefore possess, first, a first control chamber 15 and 16 respectively which has to be subjected to the action of a control pressure if the directional valves are to be adjusted in a first direction. Opposite each first control chamber is a second control chamber, 17 and 18 respectively, which has to be subjected to the action of a control pressure if the directional valves are to be adjusted in a second direction. The adjustment travel depends on the value of the control pressure.

The value of the control pressure in a control chamber can be predetermined by means of a pressure-reducing valve 25, which is continuously adjustable with the aid of a proportional solenoid 26. It has an inlet connection 27, which is connected to a control oil source 28, and an output connection 29, which is connected to tank 13. At the control output 30, and in a control line 31 departing therefrom, a control pressure is set which is determined by the force exerted by the solenoid 26.

The first two control chambers 15 and 16 of the two directional valves 10 and 11 can be connected via a first

switching valve arrangement 35 in different ways to the control line 31 or to a discharge line 36 leading to the tank 13. By contrast, the two second control chambers 17 and 18 of the directional valves 10 and 11 can be connected via a second switching valve arrangement 37, in the same way in each case, to the control line 31 or to the discharge line 36. The second switching valve arrangement consists, in both the examples of embodiment shown in figures 1 and 2 of a single 3/2-way directional switching valve which, under the action of a compression spring 38, adopts a position of rest in which the two control chambers 17 and 18 are connected to the discharge line 36, so that tank pressure prevails in them. The directional switching valve 37 can be brought by a solenoid 39 into a second switching position in which the two control chambers 17 and 18 are jointly connected to the control line 31 and the control pressure set in the control line 31 by the pressure-reducing valve 25 prevails in both control chambers 17 and 18.

In the example of embodiment shown in figure 1, the first switching valve arrangement 35 is formed by two 3/2-way directional switching valves 40 and 41, which are identical to the valve 37 and of which the first switching valve 40 controls the connection of the first control chamber 15 of the directional valve 10 to the control line 31 or to the discharge line 36 and the second directional valve 41 controls the connection of the first control chamber 16 of

the second directional valve 11 to the control line 31 or to the discharge line 36. The two directional switching valves 40 and 41 each adopt, under the action of a compression spring 38, a position of rest in which the respective control chamber 15 or 16 is connected to the discharge line 36. The directional switching valve 40 can be brought by a solenoid 42, and the directional switching valve 41 can be brought by a solenoid 43, into a second switching position in which the respective control chamber, 15 or 16, is connected to the control line 31.

In the example of embodiment shown in figure 2, the first switching valve arrangement 35 is formed by a single 4/2-way directional switching valve 45. This adopts, under the action of a compression spring 46, a first switching position in which the control chamber 15 of the first directional valve 10 is connected to the control line 31 and the first control chamber 16 of the directional valve 11 is connected to the discharge line 36. By means of a solenoid 47, the directional switching valve 45 can be brought into a second switching position in which the control chamber 15 is connected to the discharge line 36 and the control chamber 16 to the control line 31.

The pilot control device 50 shown in figure 3 possesses a handle 49, which is merely indicated, and which can be pivoted about two axes 51 and 52 extending perpendicularly to

one another. In the event of pivoting about the axis 51, a potentiometer 53 is adjusted whose output signal, the value of which depends on the pivot angle, passes via an electrical control line 54 to an analysis and amplifier circuit 55. In the event of pivoting of the handle about the axis 52, a potentiometer 56 is adjusted whose output signal is likewise dependent on the extent of the pivot angle and on the pivot direction and likewise passes via a control line 57 to the circuit 55. The circuit 55 controls the solenoid 26 of the pressure-reducing valve 25 in accordance with the signal on the control line 54 or 57.

In the electrical pilot control device 50, six electrical microswitches 58 to 63 are also accommodated, these being selectively actuated as a function of the axis about which the handle is pivoted and as a function of the pivot direction, out of a neutral position. In the event of pivoting of the handle about the axis 51 in a first direction, only the microswitch 58 is actuated after a short travel. As a result, the solenoid 42 of the directional switching valve 40 is connected to voltage. In the event of pivoting of the handle about the axis 51 in the opposite direction, the microswitches 59 and 60 are actuated, as a result of which the solenoids 39 and 43 are connected to voltage. In the event of pivoting of the handle out of the neutral position about the axis 52 in a first position, the microswitch 61 is actuated after a short travel and the

solenoid 43 is thereby connected to voltage. In the event of pivoting in the second direction about the axis 52 the microswitches 62 and 63 are actuated after a short travel and the solenoids 39 and 42 are thereby connected to voltage.

If, then, the first directional valve 10 is to be adjusted in the first direction, in order to connect the inlet connection P to the consumer connection A and the consumer connection B to the output connection T, the handle of the pilot control device 50 shown in figure 3 is pivoted out of the neutral position about the axis 51 in the first direction. As a result, first, the switch 58 is actuated and the solenoid 42 of the directional switching valve 40 is supplied with voltage. It switches this valve into the second switching position, in which the control chamber 15 of the directional valve 10 is connected to the control line 31 and is subjected to the action of the control pressure set by the pressure-reducing valve 25 on the basis of the output signal of the potentiometer 53. The control chambers 16, 17 and 18 meanwhile remain connected to the tank. If the directional valve 10 is now adjusted in the opposite direction, the handle is pivoted in the opposite direction about the axis 51. By actuation of the electrical switches 59 and 60, the two solenoids 39 and 43 are excited. The control pressure existing in the control line 31 thus acts in both control chambers 16 and 18 of the directional valve 11, so that the latter remains in its central position. The directional valve

10, by contrast, because the control pressure exists in the control chamber 17 and the control chamber 15 is connected to the discharge line 36, is adjusted in the second direction. The adjustment of the directional valve 11 in the two directions takes place in accordance with the adjustment of the directional valve 10 by pivoting the handle of the pilot control device 50 about the axis 52, and therefore need not be explained here in detail.

The pilot control device 50 shown in figure 4 is likewise suitable for use together with the example of embodiment shown in figure 1. It possesses no electrical switches but only the two potentiometers 53 and 56, which can be adjusted by pivoting the handle 49 about the axis 51 and about the axis 52, respectively. It can be assumed that the output signals of the potentiometers 53 and 56 have a positive reference value in the neutral position of the handle 49 and that the output signal of a potentiometer increases when the handle 49 is pivoted about an axis in a first direction and falls in the event of pivoting about the same axis in the opposite direction. The output signals of the potentiometers 53 and 56 pass via electrical control lines 54 and 57 to an analysis and amplifier circuit 66, which controls the solenoid 26 of the pressure-reducing valve 25 in accordance with the value of the deviation of the output signal of a potentiometer from the reference value. In addition, the circuit 66 controls the solenoids 39, 42 and 43 of the

directional switching valve 37, 40 and 41 as a function of the sign of the deviation of the output signal of a potentiometer from the reference value, if the value of the deviation reaches a particular value.

The pilot control device shown in figure 5 is intended for use together with the example of embodiment shown in figure 2 and contains, apart from the two potentiometers 53 and 56, four microswitches 59 to 62, the two microswitches 59 and 60 being actuated if the handle 49 is pivoted about the axis 51 in the second direction and the microswitch 61 being actuated if the handle 49 is pivoted about the axis 52 in the first direction, and the microswitch 62 being actuated if the handle 49 is pivoted about the axis 52 in the second direction. The output signals of the potentiometers 53 and 56 again pass through lines 54 and 57 to the circuit 55, which controls the solenoid 26.

In the event of pivoting of the handle 49 of the pilot control device 50 shown in figure 5 about the axis 51 in the first direction, then, neither the solenoid 39 nor the solenoid 47 is excited. Thus the pressure set in the control line 31 by the pressure-reducing valve 25 is established, via the directional switching valve 46, in the control chamber 15 of the directional valve 10, so that the latter is adjusted in one direction. If the handle 49 is pivoted out of the neutral position about the axis 51 in the opposite direction,

the electrical switches 59 and 60 are actuated and the two solenoids 39 and 47 are thus excited, so that the two directional switching valves 37 and 46 pass into the switching positions other than the switching positions shown in figure 2. Control pressure now prevails in the control chambers 16 and 18 of the directional valve 11 and in the control chamber 17 of the directional valve 10 while its control chamber 15 is discharged to the tank 13. The directional valve 10 is thus adjusted in the second direction.

For an adjustment of the second directional valve 11 in the first direction, the electrical switch 61 is actuated and the solenoid 47 is thus controlled and the directional switching valve 46 brought into the second switching position. Only the control chamber 16 of the second directional valve 11 is now subjected to the action of control pressure, so that this directional valve is adjusted in the first direction. For the adjustment of this second directional valve 11 in the second direction, the solenoid 39 is switched, so that the control spaces 15 and 17 of the directional valve 10 and the control space 18 of the directional valve 11 are subjected to the action of control pressure.